



OVERVIEW OF PAYLOAD PROCESSING AT KENNEDY SPACE CENTER

Presentation to the
**5th International Workshop on Lunar Surface
Applications**

April 2015

Presenter: /NASA-KSC



Outline of Presentation Topics

- KSC Mission/Core Competencies
- History of KSC Payload Processing
- Current Focus on Payload Processing
- KSC Capabilities
- Current Work
- Summary



KSC Mission & Core Competencies

KSC's Mission

- KSC safely manages, develops, integrates, and sustains space systems through partnerships that enable innovative, diverse access to space and inspires the Nation's future explorers.

KSC's Core Competencies

- Design and Development of flight systems and transformational technologies
- Vehicle, Spacecraft, and Payload Testing, Processing, and Operations
- Acquisition and Management of Launch Services and Commercial Crew

KSC's Long-Standing Core Competencies are directly related to flight opportunities and small satellite technology



KSC's History in Payload Processing



Inspection of the Mercury Capsule Heat Shield



Integrating a CubeSat for an Educational Launch of Nanosatellites (ELaNa) Program mission



Preparing the Project Morpheus Prototype Lander for a Tether Test



Test Flight with the Rocket University Payload Launch and Recovery Lab

Payload Installation during the STS-135 Space Shuttle Mission





ISS Payload Integration Methodology

- **Typical Payload Life Cycle Time = 36 Months**
 - **Strategic** (L-36M to L-16M)
 - Requirements Definition
 - Design, Development, and Test
 - **Tactical** (L-16M to Launch)
 - Mission Integration – ensure integration and operations requirements are met
 - Oversight for Payload Certificate of Flight Readiness (CoFR)
 - **Operations** (~6Months)
 - Issue Resolution
 - Preparation for Payload Resupply/Return
 - **Post-flight**
 - Coordinate De-Integration Requirements
 - Coordinate Return of Payload Material

A NASA Payload Integration Manager provides integration leadership during all phases of the payload's life cycle



NEW!

KSC Interest in Small Satellites

- Our focus at KSC has been to create a Multi-User Spaceport, facilitate commercial access to space, and to foster technical collaboration.
- There are natural advantages in responsiveness by maintaining complimentary payload integration capabilities alongside our strong launch service capabilities
- Would like to utilize small satellite/payloads to mature and qualify critical space technologies, to maximize the investment made in R&T development.
 - Technology development is in support of NASA and KSC mission and goals.



Why Should NASA Focus on Small Payloads?

A rapidly growing market for the nation...

- SmallSat market is maturing with many commercial and Government entities involved in satellite development, testing, instrument development, component production, launch and mission operations.
- KSC is already substantially and successfully engaged in a variety of SmallSat development activities.

To help mature and qualify critical technologies...

- A long-standing issue is the overall lack of progress in the maturation of space, spaceport and range technologies, to 'push', or allow their incorporation, into current and near-term space mission planning.
- Most of these technologies require a flight test or qualification in a relevant environment before the technology is 'proven', and there is a backlog of technologies that have awaited flight testing for several years.



Why Should NASA Focus on Small Payloads?

To pursue emerging business opportunities...

- The NASA FY15 budget request highlights several areas where investment is being made in technology development, small satellites, and space commercialization.
- KSC Payload processing expertise and capabilities can readily support and enable several NASA goals.



Payload Processing Capabilities

Portfolio of Services includes:

- Systems engineering expertise to package science for flight opportunities
- Rapid prototyping support to handle the space launch environment
- Modeling and simulation to support mission execution
- Materials and Parts selection expertise
- Small Satellite fabrication and assembly
- Testing services to simulate the space/launch environment (e.g. vibration, thermal cycling)
- Integration of small payloads in preparation for missions
- Hands-on experience with small-scale flights (balloon and sub-orbital)



Payload Processing Capabilities

KSC Labs Supporting Payload Processing:

- Applied Chemistry and Physics
- Chemical and Sampling Analysis
- Controlled Environment
- Cryogenics
- Customer Avionics Development & Analysis
- **Electromagnetic Laboratory**
- Electronics Development
- Embedded Systems Development
- Institutional Non-Destructive Evaluation
- Instrumentation and Data Acquisition
- **Materials Testing and Evaluation**
- **Vibration**
- **Thermal Vacuum**
- **Prototype Development**
- Range Technology Development
- Spaceport Processing Systems Development



KSC Electromagnetic Laboratory

Capabilities/Services

- Electromagnetic (EMC) Rapid Prototyping Services
- EMC Programmable Logic Controller (PLC) and Controls Development
- Electromagnetic Effects (EME) Requirements Development, Design and Certification
- Reradiating Antenna System (RAS) Passive/ Active Fiber Optics
- RADAR Shielding/Masking Effectiveness Measurements
- Electromagnetic Environment Surveillance System that are Fixed and Portable
- Electromagnetic Laboratory (EML) Operation Control Room
 - Mobile/Fixed
 - Test Fixtures, Test Standards and Simulators
 - Standards
 - Automated Test Software Development



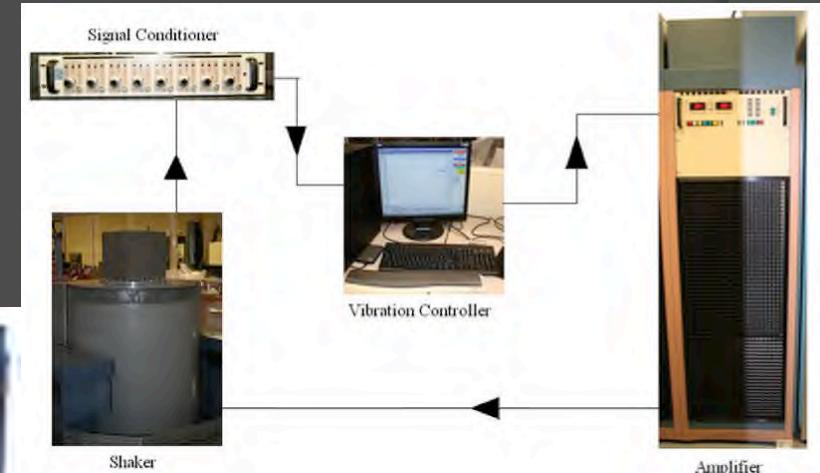


KSC Vibration Laboratory

Typical Vibration Tests Performed at KSC

- Sinusoidal
- Random
- Shock
 - Classic (half sine, saw tooth, etc.)
 - Shock Response Spectrum (SRS)
 - Imported Pulse
- Superimposed
 - Random on Random
 - Sine on Random

- Gunfire
- Sine Burst





KSC Material Testing and Evaluation

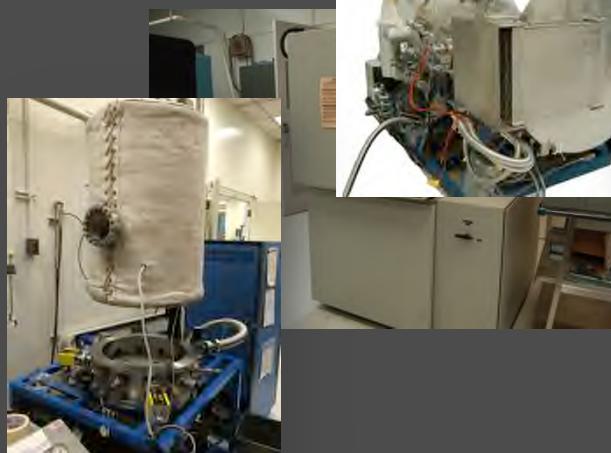
Environmental Testing

- Walk-in Environmental Test Chamber
 - Temperature and Humidity Testing



Thermal/Vacuum Testing

- Slack Chamber



- Bell Jar



- Large Thermal Vacuum Chamber



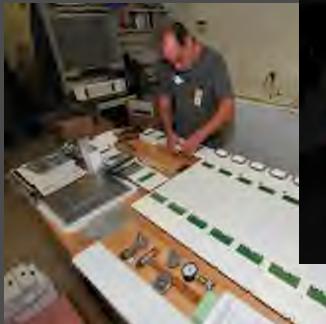
- Cincinnati Sub-Zero



Prototype Development Lab Services

- Support To Engineering Development and Research
- Rapid Solutions to Complex Problems
- “Design For Manufacturability” Consulting
- “Smart Buyer” of Manufactured Products

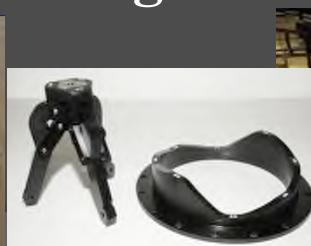
Electrical Integration Services



Mechanical Engineering Services



Design Engineering Services





Example KSC Small Satellite Initiatives

- **StangSat** (1U Cubesat)

- NASA mentorship to High School student team. Measures launch environment experienced by CubeSats and wireless communications to CalPoly CP9 CubeSat.

- **CryoCube** (3U Cubesat)

- Cryogenic Fluid management experiments including fluid location sensing, slosh characterization and cryogenic fluid transfer.

- **Rocket University** (RocketU)

- Engineering development programs which includes hands on payload development, mission design, systems engineering and mission execution.
 - Exposing Microorganisms in the Stratosphere (EMIST)
 - Rocket University Broad Initiatives CubeSat (RUBICS)

- **CubeSat Launch Initiative (CSLI)/ELaNa** (Educational Launch of Nano Satellites)

- Administered by Launch Services Program
- Flight opportunities provider for CubeSat missions primarily geared toward Schools and Academia



Summary

- KSC's expertise in payload processing spans more than 50 years.
- Building on our payload heritage, KSC is increasing focus on small payloads through the use of our services and expertise to help encourage the commercial space market and aid in the Center's transformation into a Multi-User Spaceport.
- KSC intends to use small payloads as a low-cost platform for flight testing new technologies needed to meet the Agency and Center's mission and goals.



Thank you for your time today!

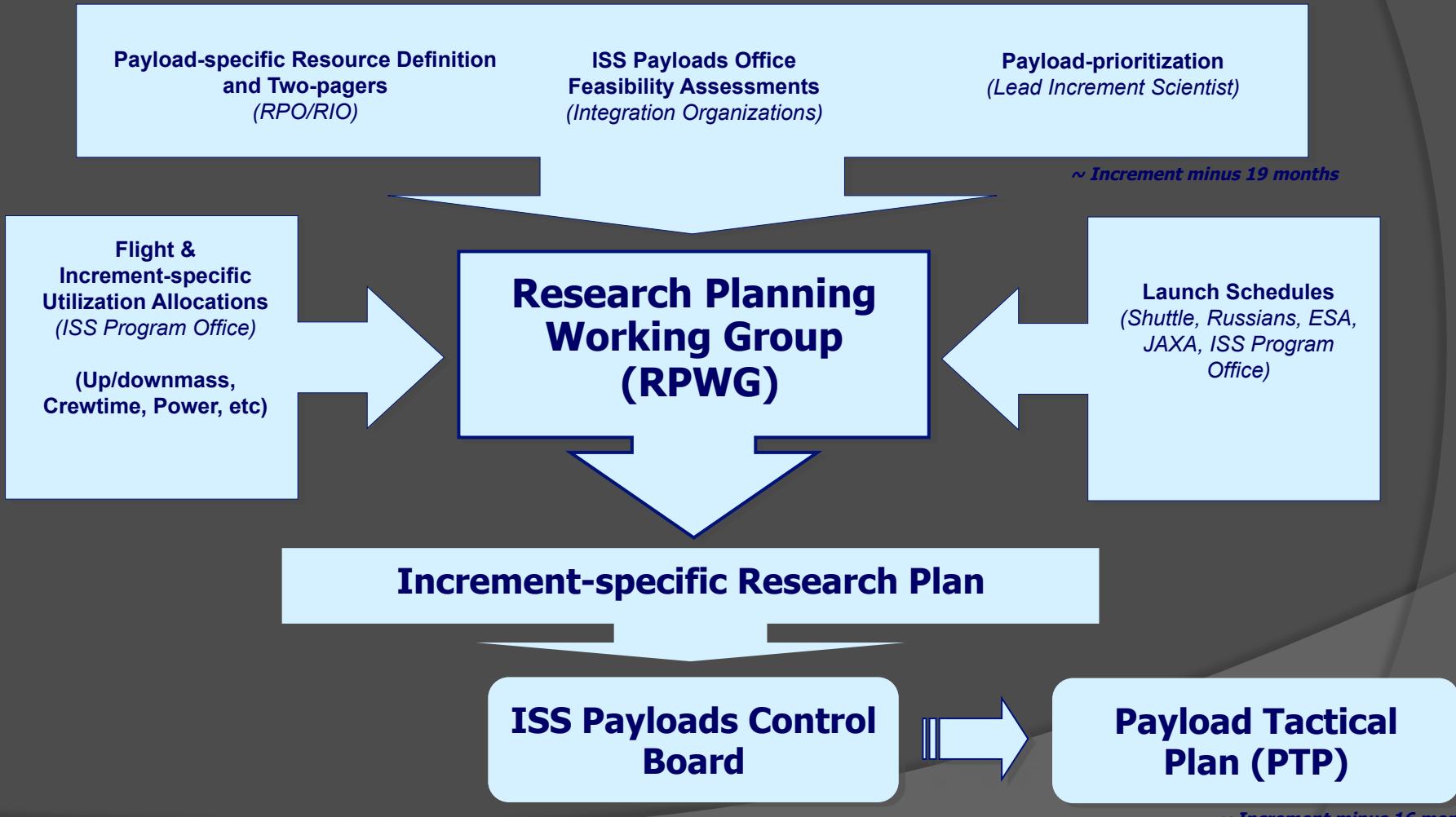


Backup



Getting Manifested!

A payload's RPO sponsor initially responds to the RPWG "Call for Payloads" with a list of candidate payloads and resource requirements for consideration. This action starts the manifesting process for you.



≈ Increment minus 19 months



KSC Electromagnetic Laboratory

Capabilities/Services

- Rapid Prototype
 - EMC Development & Testing Certification
 - Radio Frequency Monitoring
 - Vehicle Processing Electromagnetic Environment Measurement
- EMC PLC/Controls/ATE Development
- EME Requirements Development, Plans, & EMI
- Electromagnetic Effects Analysis & Hardware Design Certification
- Reradiating Antenna System (RAS) Passive/Active Fiber Optics
- RADAR Shielding/Masking Effectiveness Measurements
- Electromagnetic Environment Surveillance System that are Fixed and Portable
- Geo-Location to Assist in RFI Detection and Resolution
- EML Operation Control Room
 - Convoy Payload Operations
 - Launch Day Electromagnetic Environment Surveillance
- Standards
 - Mil Std-461 (10kHz-40GHz)
 - IEEE-299
 - RTCA DO-160E
- Automated Test Software Development
 - C, Pascal, VEE, etc.
- Support Classified Operations (Secret Clearances)



Test Fixtures

- 3 Test Chambers
- Lightning Test Simulator
- RF Test Fixtures
- Avionics Certification
- Test Equipment Certification

3 Test Chambers



Development Shops & Labs

- EMC Sensor Shop
- RFI Monitoring Shop
- RF Data Acquisition System Laboratory



Specialized On-Site EMC Testing



EMC Sensor Verification



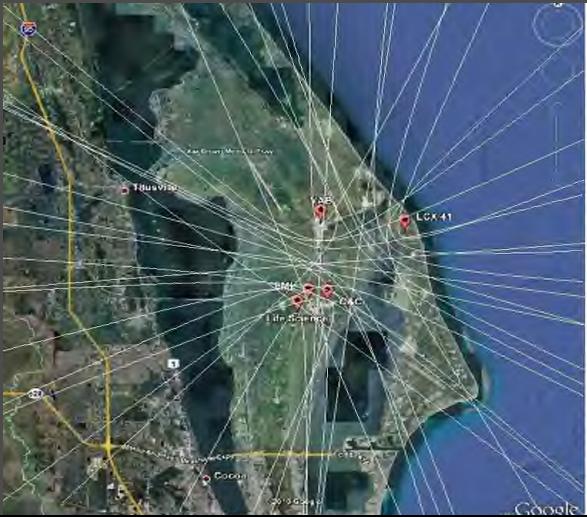
Rapid Response Electromagnetic Customized Environment Monitoring, EMC Certification, EMC Modeling



KSC Electromagnetic Laboratory

ELECTROMAGNETIC LAB (EML)

Real Time Automated RF Monitoring System (ARFMS)



CAPABILITIES / SERVICES

ACCOMPLISHMENTS

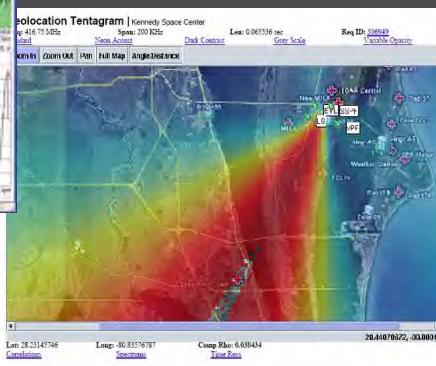
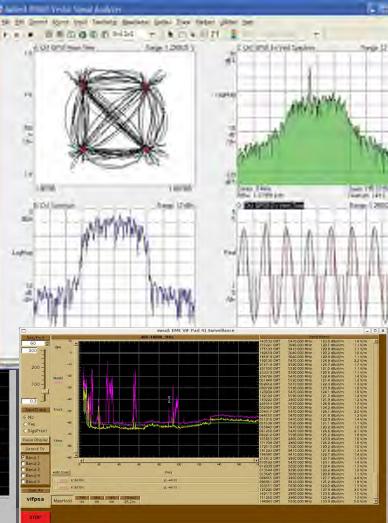
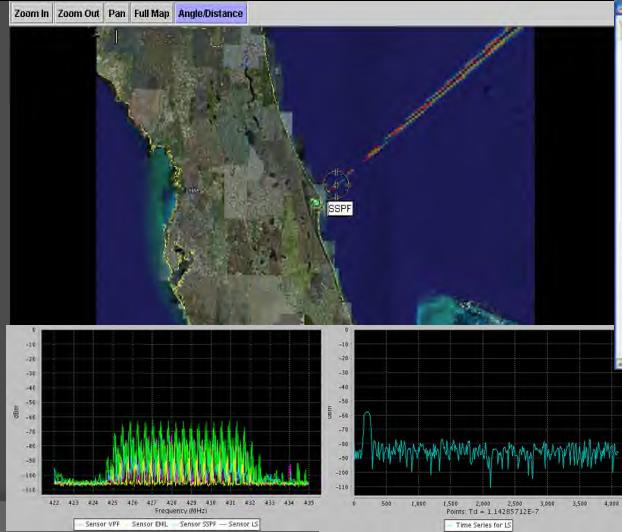
- Flight Termination radio frequency interference issue when a flight avionic box was having intermodulation problem with local hand held radio communication system. The EML team triangulated the interference to perform mitigation for launch day for Shuttle Program.
- RADAR Shielding/Masking effectiveness measurements
- Wi-Fi entering into Spacecraft Processing Facilities
- Rapid prototype for radio frequency monitoring and vehicle processing electromagnetic environment measurement
- Electromagnetic Environment Surveillance System that are fixed and portable
- Geo-Location to assist in RFI detection and resolution.

EQUIPMENT / FACILITIES

Support Systems

- EML Operation Control Room in support of convoy payload operations and launch day electromagnetic environment surveillance.

KSC EML Operation Control Room

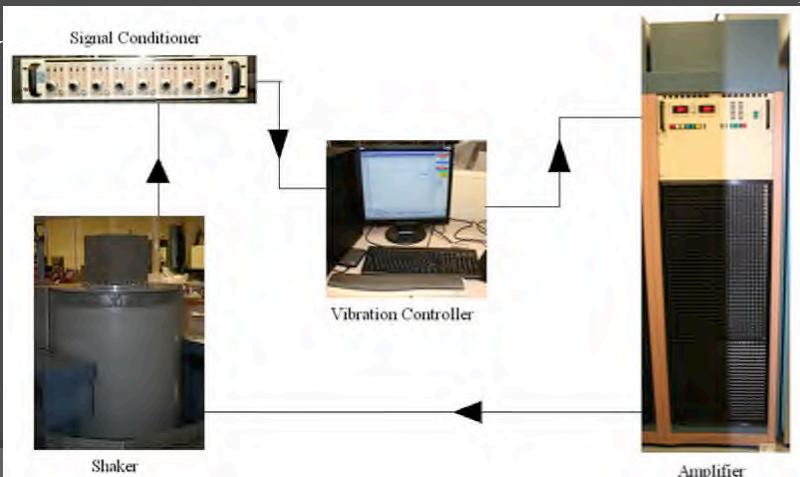




KSC Vibration Laboratory

Typical Vibration Tests Performed at KSC

- Sinusoidal
- Random
- Shock
 - Classic (half sine, saw tooth, etc.)
 - Shock Response Spectrum (SRS)
 - Imported Pulse
- Superimposed
 - Random on Random
 - Sine on Random
- Gunfire
- Sine Burn



Other Services Provided by Vibration Lab

- Video Documentation
 - Two High Speed Cameras with synchronized LED Lighting
 - Two HD SDI Box Cameras
- High Speed Data
 - Sixteen Channels Sampled @ 12,288 Hz
 - Laser Vibrometer Controller outputting velocity and displacement
- Synchronized Multiplexed Test Record
- Standard and Custom Fixtures can be Fabricated
 - Generic Fixtures
 - Cube, Disk, L-Shape, Conical, etc.
 - Payload Specific Fixtures
 - ISS Mid-Deck Locker
 - CubeSats 1U, 3U, PPOD, etc.



KSC Material Testing and Evaluation

Slack Chamber

- Thermal-Vacuum Chamber
 - Variable Temperature, -184 to 204°C (-300° F to 400°F)
 - Variable Pressure, Ambient to 1×10^{-7} Torr
- Chamber Size
 - Diameter = 3'(0.91m) Length = 3'(0.91m)
- Hot/Cold Plate
 - Size: 2'(0.61m) X 2'(0.61m) X 3'(0.91m)
 - Bolt Pattern: 4" x 4" Grind Pattern
 - Bolt Size: 3/8"-16 Thread



Bell Jar

- Thermal-Vacuum Chamber
 - Variable Temperature, -10 to 100°C (14° F to 212°F)
 - Variable Pressure, ambient to 1×10^{-6} Torr
- Testing Area
 - Diameter = 18"(0.46m) Height = 2"(0.61m)





KSC Material Testing and Evaluation

Large Thermal Vacuum Chamber

- Thermal-Vacuum Chamber
 - Variable Temperature, -72 to 177°C (-100° F to 350° F)
 - Variable Pressure, ambient to 1 Torr (1mm Hg)
- Testing Area
 - 4'(1.22m) X 4'(1.22m) X 5'(1.52m)



Cincinnati Sub-Zero

- Thermal-Vacuum Chamber
 - Variable Temperature, -45 to 177°C (-49° F to 350° F)
 - Variable Pressure, Ambient to 1 Torr (1mm Hg)
- Testing Area
 - 2'(0.61m) X 2'(0.61m) X 2'(0.61m)



Walk-in Environmental Test Chamber

- Temperature & Humidity Testing
 - Variable Temperature, -34 to 85°C (-30° F to 185°F)
 - Variable Humidity, 5% to 95% RH
- Testing Area
 - 8'(2.43m) x 8'(2.43m) x 8'(2.43m)





KSC Prototype Development Lab Services

Design Engineering Services

- Mechanical engineering design
- Mechanisms and kinematics
- ProE CAD/CAM
- "Design for Manufacturability" consultation
- Structural and finite element analysis



Mechanical Engineering Services

- Pneumatics and Hydraulics Fabrication
- Rapid Prototyping/Additive Manufacturing
- Mechanical & Structural Fabrication and Testing
- Computer Numeric Control (CNC) Machining
- Sheet Metal Fabrication
- Welding & Soldering
- Composite Materials Fabrication

Electrical Integration Services

- Power and Electrical Systems
- Electrical Fabrication
- Data Acquisition
- LabView Software Programming

